Real Exchange Rate Fluctuations and the Dynamics of Retail Trade Industries on the U.S.-Canada Border

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Abstract

This paper examines the effects of U.S.-Canadian real exchange rate movements on U.S. retail trade industries in states that border Canada. Using county level data, we focus on the effects on the number of establishments, employment, and payroll in two and three digit level retail industries. We expect fluctuations in the real exchange rate to affect these variables as movements in these relative price series impact on the incidence of cross-border shopping. This, in turn, affects the demand facing retailers located in each country and industries will respond to changes in demand by changing output per firm and/or the number of firms operating in the industry. Our results suggest that for many of the industries in our sample, real exchange rates have a significant effect on these variables and these effects vary across industries.

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1 Introduction

This paper examines the effects of U.S.-Canadian real exchange rate movements on U.S. retail trade industries in states that border Canada. Using county level data, we focus on the effects on the number of establishments, employment, and payroll in two and three digit level retail industries. Our results suggest that for many of the industries in our sample, real exchange rates have a significant effect on these variables and these effects vary across industries. In the remainder of the introduction, we explain why one might expect the real exchange rate to influence these variables and what can be learned from our empirical results.

It is widely known that there exist large and persistent deviations from purchasing power parity (PPP) (see Rogoff (1996) for a survey of the evidence). Furthermore, work by Engel (1999,1993), Engel and Rogers (1999,1996), Rogers and Jenkins (1995) and others indicates that movements in the relative prices of traded goods between the U.S. and Canada accounts for a large portion of the movement in real exchange rates between those two countries. These authors use disaggregated consumer price data for U.S. and Canadian cities to demonstrate that while distance affects differences in prices of a good sold in different cities, the effect of the border relative to distance is very large.

These international price differences, then, should lead to arbitrage opportunities for consumers who are willing to cross the border to purchase goods from retail stores which are selling goods at lower prices than their foreign counterparts. Indeed, Di Matteo (1999,1993), Di Matteo and Di Matteo (1996,1993) provide compelling evidence that trips by Canadians to the U.S. and real per capita expenditures by Canadians in the U.S. are significantly affected by the real exchange rate. Figure 1 and Table 1 provide additional evidence that price differences between the U.S. and Canada affects the number of same-day trips across the U.S.-Canadian border (a standard measure of 'cross-border shopping" or 'outshopping").

Figure 1a depicts the nominal exchange rate (Canadian dollars per U.S. dollar) and the real exchange rate constructed using aggregate consumer price indexes from 1972-1998. Figures 1b and 1c depict same day automobile trips by U.S. vehicles into Canada and by Canadian vehicles into the U.S., respectively, over that same time period. The appreciation of the Canadian dollar from 1986-1992 is accompanied by a large increase in trips by Canadians and a slight decrease in trips by Americans. The subsequent depreciation of the Canadian dollar from 1992-1998 is accompanied by a large decrease in trips by Canadians and a large increase in trips by Americans. Furthermore, the spike in U.S. auto trips in 1980 and 1981 came at a time when the Canadian National Energy Policy dramatically reduced the price of gasoline in Canada relative to the U.S.

Table 1 presents Spearman rank correlation coefficients between growth rates of the real exchange rate and growth rates of same day trips by Americans and Canadians for all of Canada and for provinces where such travel occurs. These coefficients are of the expected sign (except for U.S. trips in Saskatchewan). In addition, they are significant for trips by Canadians for all of Canada and for every province and significant for trips by Americans for all of Canada and for two of the seven provinces. These results and the results contained in Di Matteo (1999,1993) and Di Matteo and Di Matteo (1996,1993) for other years provide evidence that at least some consumers' decisions to cross the border are affected by real exchange rates. In addition, Ford (1992) provides survey data and discusses findings from other surveys which indicate that the primary reason that Canadians shop in the U.S. is because of lower prices.

This evidence suggests that movements in the real exchange rate can affect the number of consumers which arrive at a particular retail store to shop. Hence, movements in the real exchange rate can act as a demand shock for retail stores which are affected by cross-border shopping. Section 2 of this paper presents a spatial model of heterogeneous consumers and firms with free entry to illustrate this. In that model, firms located in two different countries face costs denominated in their own currency and set prices in their own currency. We demonstrate that in that environment, fluctuations in the nominal exchange rate affect the demand for a firm's product and, therefore, have real effects on the industry. In particular, in that free entry environment, the number of firms operating in the industry responds to movements in the exchange rate. Although we analyze a model with free entry in that section, it should be clear that in an environment without entry that output per retailer will respond to exchange rate movements.

In reality, one would expect industries to respond to exchange rate movements along both the intensive margin (changes in output per firm) and along the extensive margin (changes in the number of firms operating in the industry). Furthermore, focusing on labor input, changes in output per firm can be accomplished by variation in the number of workers, the number of hours per worker, and/or the effort by each worker. Indeed, Ford (1992) cites a number of studies (most of which were commissioned by Canadian government officials) which indicate that the effects on Canadian retailers of a decrease in demand in the late 1980's and early 1990's included lower sales, fewer jobs, and higher rates of bankruptcy.

This reasoning motivates the empirical analysis contained in Section 3. In that section we use annual data for retail trade industries' payroll, employment, and number of establishments for U.S. counties located in states which border Canada to characterize the responses of these industries to fluctuations in real exchange rates. The effects on payroll and employment give insight into the responses of these industries along the intensive margin, although we do not have a variable to measure effort. The effects on number of establishments provides information regarding the responses of these industries along the extensive margin.

We discuss this data and our econometric methodology in detail in Section 3, but it is useful at this point to briefly examine a single U.S. county to illustrate why we might expect this data to detect a significant effect of exchange rate movements on these variables. Ford (1992) describes some of the effects of cross-border shopping in the cities of Blaine, Washington and Bellingham, Washington, both of which are located in Whatcom county. She states that 'In November, 1990, Blain International Center opened with 70,000 square feet and 16 tenants. Business has grown rapidly and plans are underway to double the size of the plaza and to add another 14 stores [Kidd,Jun.17,1991,p.B9]. Revenues have been rising 20 percent annually at the Bellis Fair Mall in Bellingham, Washington,..." Figure 2 depicts payroll, employment, and number of establishments in retail trade in Whatcom county, Washington from 1977-1995. The figure also presents annual averages over that same time period of the U.S.-Canadian real exchange rate constructed using aggregate CPI's. These figures indicate that all three variables rose dramatically from 1986-1991 when the Canadian dollar appreciated and leveled off or fell since 1992 when the Canadian dollar began depreciating.

In the regression analysis we use ten two and three digit level retail trade industries for counties in border states and employ two different criteria for identifying counties which we expect to be exposed to cross-border shopping. Using a criterion which emphasizes geographic proximity to the border, we find significant effects of relative price movements on payroll, employment, and establishments for a number of industries. In particular we find effects for groceries, service stations, restaurants, and miscellaneous stores. These results are not too surprising given the results of surveys contained in Ford (1992) indicating that two of the top three items that Canadian shoppers purchase in the U.S. are gasoline and groceries. A more surprising result is that we do *not* find significant effects in apparel although Ford's data suggest that this item is at least as important as groceries and gasoline in cross-border purchases. This may suggest that the primary adjustment in this industry to changes in demand occurs through workers' effort rather than through hours, employment, or entry and exit.

When we use a criterion that emphasizes proximity to a populated area of Canada for identifying counties which are exposed to cross-border shopping, we get much weaker results. For example, we do not find significant effects on payroll, employment, or number of establishments in the service station industry of movements in the relative price of gasoline. These results suggest that geographic proximity to the international border may be a superior method for identifying counties that are exposed to cross-border shopping.

Our empirical results, then, indicate that fluctuations in international relative prices between the U.S. and Canada have real effects on retail industries located near the border. This suggests that it is important to gain an understanding of the forces which lead to movements in these international relative prices series (i.e. deviations from the law of one price) and this is currently a very active area of research. The work of Engel (1999,1993), Engel and Rogers (1999,1996), Rogers and Jenkins (1995) and the empirical work surveyed by Goldberg and Knetter (1997) point to a number of forces including nominal price stickiness and national markets for consumer goods. In the open economy macroeconomic literature, Chari, Kehoe, and McGratten (1999) and Lapham and Vigneault (1999) examine dynamic, stochastic, general equilibrium models which generate persistent deviations from the law of one price and PPP. Continued research in this area will increase our understanding of deviations from the law of one price.

Furthermore, given that our results indicate that different industries respond in very different ways to movements in the international relative prices, this analysis suggests that models which seek to determine the response of industries to aggregate (demand) shocks should carefully consider the characteristics of the industries. This applies to micro models of industry dynamics such as Bergin and Bernhardt (1996), Hopenhayn (1992), Ericson and Pakes (1995), Pakes and Ericson (1995) and others as well as macro models of aggregate fluctuations.

Finally, many of these models of industry dynamics have testable implications regarding an industry's dynamic response to aggregate shocks. The empirical work in this paper points to a promising data set and an empirical framework for testing those implications.

The remainder of the paper is organized as follows. Section 2 presents a spatial model of cross-border shopping. Section 3 describes the data and econometric methodology used in the empirical analysis. Section 4 presents empirical results and Section 5 concludes and discusses future work.

2 A Model of Cross-Border Shopping

Before proceeding with the empirical analysis, it is helpful to use a simple free entry model of a retail trade industry on an international border to illustrate what can be learned from our regressions. In the model industry, consumers in two countries can potentially purchase a good from a large number of producers located in both countries. Competition takes place in two stages. In the first stage, potential producers in both countries simultaneously make their entry decisions. In the second stage, active producers in both countries simultaneously choose their prices. The producers in each country use a common technology that displays constant marginal cost, and each producer's residual demand curve has a constant elasticity of demand.

If producers' costs, denominated in their domestic currencies, are sticky and fail to respond to changes in the nominal exchange rate, then exchange rate changes will have real effects on this industry, inducing consumers to shift their purchases away from the "high cost" producers in one country and towards "low cost" producers in the other. How the industries accommodate these shifts depends on the ease with which entry and exit can modify an industry's composition in the short run. In the simple case where producers repeat the two stage free entry game every period, then changes in the number of producers accommodate all industry fluctuations. In the polar opposite case where the number of producers is fixed in the short run, individual establishments expand and contract. This model economy should not be thought of as characterizing the "typical" retail trade industry. In fact, Campbell and Hopenhayn (1999) provide evidence from U.S. cities' retail trade industries against this and other models that predict establishment sizes to be invariant to the size of the customer population. Nevertheless, the model provides a simple framework for illustrating how nominal exchange rate fluctuations can have real effects on the retail trade industries of border areas.

2.1 Producers and Consumers

Consider an industry for a single good, say gasoline for automobiles. There are M service stations and N consumers, each of whom wishes to purchase at most one tankful of gasoline. For simplicity, we assume that each service station offers exactly one variety of gasoline for sale. Consumers have heterogeneous tastes over gasoline, so if one service station raises its price above all others, some consumers will still choose to purchase gasoline there. Consumers and service stations reside in two locations, A (for the United States) or C (for Canada). We identify service stations and consumers as American or Canadian based on their locations. We order both service stations and consumers so that the first M_a stations and N_a consumers are American, and the last $M_c = M - M_a$ stations and $N_c = N - N_a$ consumers are Canadian.

Two currencies are used for trade, United States' dollars ($US) and Canadian dollars, ($C). These can be exchanged costlessly for each other at the rate of E $US for each $C. All stores in each country incur a constant marginal cost for each tankful of gasoline sold. These costs, r_a and r_c, are denominated in each country's own currency. Without loss of generality, we assume that stations seek to maximize profits as denominated in their home currencies. The stations simultaneously choose their prices, which we again assume are set in their home currencies. Let p_j denote the price station j chooses in its home currency.

With these prices set and with complete information regarding each station's prices, consumers simultaneously make their purchase decisions. A consumer can choose to purchase one tankful of gasoline from one station or to not purchase any gasoline. A consumer's utility from these options depends on her home country and on a set of random "preference shocks" which are observable only to her.

First consider the preferences of an American consumer. If consumer $i < N_a$ purchases gasoline from an American station, $j \leq M_a$, her realized utility is

$$u(i,j) = -\eta_a \ln p_j + \varepsilon(i,j).$$

If she purchases gasoline from station $j > M_a$ located in Canada instead, her utility is

$$u(i,j) = -\eta_a \ln Ep_j - \beta_a + \varepsilon(i,j)$$

Lastly, if consumer i chooses to consume no gasoline and perhaps use an alternative transportation mode, then her realized utility is

$$u(i,o) = \alpha_a + \varepsilon(i,o),$$

where the index o stands for "outside option". The coefficients η_a and β_a are both positive. The consumer's realized utility from a given purchase is decreasing in its $US price, and it is lower if the purchase requires traveling to Canada. The specification of preferences in terms of $US denominated prices is inconsequential. We assume that the preference shocks $\varepsilon(i,j)$ and $\varepsilon(i,o)$ are type I extreme value random variables that are *i.i.d.* across both individuals and purchase options.

Each consumer chooses the option that gives her the highest realized utility. Therefore, the probability that consumer i will purchase from store j is given by the familiar logit specification. If we let $z(i) \in \{1, \ldots, M\} \cup o$ indicate consumer i's choice for $i \leq N_a$, then for $j \leq M_a$

$$\begin{aligned} \Pr[z(i) = j] = {} & \exp\{-\alpha_a - \eta_a \ln p_j\} \\ & / \left(1 + \sum_{l=1}^{M_a} \exp\{-\alpha_a - \eta_a \ln p_l\} \right. \\ & \left. + \sum_{l=M_a+1}^{M} \exp\{-\alpha_a - \eta_a \ln Ep_l - \beta_a\}\right). \end{aligned} \tag{1}$$

Similarly, for $j > M_a$, we get

$$\begin{aligned} \Pr[z(i) = j] = {} & \exp\{-\alpha_a - \eta_a Ep_j - \beta_a\} \\ & / \left(1 + \sum_{l=1}^{M_a} \exp\{-\alpha_a - \eta_a \ln p_l\} \right. \\ & \left. + \sum_{l=M_a+1}^{M} \exp\{-\alpha_a - \eta_a \ln Ep_l - \beta_a\}\right). \end{aligned} \tag{2}$$

The specification for Canadian consumers' preferences is different from that of American consumers in two respects. First, the parameter values may be different. Let α_c, η_c, and β_c denote the Canadian counterparts to these parameters. Second, Canadian consumers incur the utility cost β_c whenever they purchase from an American station, and they incur no such cost when visiting a Canadian station. The expressions in (1) and (2), appropriately modified, also describe Canadian consumers' purchase probabilities.

2.2 Equilibrium Pricing

American and Canadian consumers' choice probabilities can be easily aggregated to produce the demand curve for each producer as a function of all service stations' prices, collected in the vector P. Let $g_a(P,E)$ denote the denominator in $Pr[z(i) = j]$ given by equation (1) or (2) for American consumers and let $g_c(P,E)$ denote the symmetric denominator for Canadian consumers. The expected number of units of gasoline sold by an American station, $j \leq M_a$ is

$$\begin{aligned} D(j,P,E) = {} & p_j^{-\eta_a} N_a \frac{\exp(-\alpha_a)}{g_a(P,E)} \\ & + p_j^{-\eta_c} N_c \frac{\exp(-\alpha_c - \beta_c)}{g_c(P,E)}. \end{aligned}$$

For a Canadian station, $j > M_a$, expected quantity sold is

$$\begin{aligned} D(j,P,E) = {} & (Ep_j)^{-\eta_a} N_a \frac{\exp(-\alpha_a - \beta_a)}{g_a(P,E)} \\ & + (Ep_j)^{-\eta_c} N_c \frac{\exp(-\alpha_c)}{g_c(P,E)}. \end{aligned}$$

Now both $g_a(P,E)$ and $g_c(P,E)$ are decreasing in E, so a depreciation of the \$US (an increase in E) acts as a positive demand shock for American stations, given constant prices in \$C at Canadian stores. It can also be easily shown that a depreciation of the \$US decreases demand for gasoline sold by Canadian stations. For expositional simplicity, we will denote the first term in these expressions as $D_a(j,P,E)$, and the second term with $D_c(j,P,E)$. These are the demands of American and Canadian consumers for the store's product.

For an American station, $j \leq M_a$, the profit maximization problem is

$$\max_{p_j} D\left(j, p_j, P_{-j}, E\right)\left(p_j - r_a\right),$$

where P_{-j} is the vector of all other stations' prices. If we assume that the number of stations is large, then the influence of p_j on $g_a\left(P, E\right)$ and $g_c\left(P, E\right)$ will be small. If the station manager ignores this aspect of the demand curve, the first order condition for the profit maximizing price is

$$\frac{\eta_a}{p_j} D_a\left(j, P, E\right)\left(p_j - r_a\right) + \frac{\eta_c}{p_j} D_c\left(j, P, E\right)\left(p_j - r_a\right) = D\left(j, P, E\right).$$

Rearranging this yields the usual inverse-elasticity markup pricing rule.

$$\frac{p_j - r_a}{p_j} = \left(\frac{\eta_a D_a\left(j, P, E\right) + \eta_c D_c\left(j, P, E\right)}{D\left(j, P, E\right)}\right)^{-1}$$

Here, store j's demand elasticity is the weighted average of the elasticities of American and Canadian consumers, where the weights equal the shares of the station's customers from the two countries. These shares clearly depend on the pricing decisions of all other firms, so this markup pricing rule does not immediately reveal store j's optimal price except in the special case where $\eta_a = \eta_c = \eta$. Because it vastly simplifies the remainder of the analysis, we proceed under this assumption below. Under this assumption, we get the result that all stations charge the same markup over their marginal costs, denominated in their home currencies.

$$\frac{p_j - r_a}{p_j} = \eta^{-1} \text{ for } 1 \leq j \leq M_a$$
$$\frac{p_j - r_c}{p_j} = \eta^{-1} \text{ for } M_a < j \leq M$$

Denote the common prices charged by American and Canadian stations as p_a and p_c, respectively.

2.3 Free Entry

We now wish to determine the number of service stations operating in each country. Let F_a and F_c denote the fixed costs of establishing a station in the

United States and Canada, and let $\pi_a(M_a, M_c)$ and $\pi_c(M_a, M_c)$ denote the expected ex-post profits accruing to a station in the United States and Canada when M_a stations operate in the United States and M_c stations operate in Canada. Clearly, both of these profit functions are strictly decreasing in both of their arguments.

A free entry equilibrium is a pair, (M_a, M_c), such that

$$\pi_a(M_a, M_c) \leq F_a \tag{3}$$

$$\pi_c(M_a, M_c) \leq F_c, \tag{4}$$

where (3) holds with equality if $M_a > 0$ and (4) holds with equality if $M_c > 0$. Clearly, this definition ignores the constraint that M_a and M_c take on integer values. In large markets with many producers entering in equilibrium, we expect the solution to this continuous free entry game to approximate well the true free entry game.

We can define the free entry reaction function for each country as $M_a^\star(M_c)$ and $M_c^\star(M_a)$ as the unique number of stores in each country that satisfies the free entry condition for that country given the number of stations in the other country. That is, if $\pi_a(0, M_c)$ is greater than F_a, then $M_a^\star(M_c)$ satisfies

$$\pi_a(M_a^\star(M_c), M_c) = F_a.$$

Otherwise, $M_a^\star(M_c)$ equals zero. Similarly, $M_c^\star(M_a)$ equals zero unless $\pi_c(M_a, 0)$ is greater than F_c, in which case it satisfies.

$$\pi_c(M_a, M_c^\star(M_a)) = F_c$$

Using the implicit function theorem, it is straightforward to demonstrate that both reaction functions are decreasing, continuous everywhere, and differentiable almost everywhere, so the existence of a free entry equilibrium is immediate. We assume that

$$\pi_a(0,0) > F_a$$

$$\pi_c(0,0) > F_c,$$

so that all equilibria entail positive entry in at least one country.

The uniqueness of a free entry equilibrium follows from the demonstration that a single crossing property characterizes the free entry reaction functions. That is

$$\frac{\partial M_c^\star(M_a)}{\partial M_a} > \left(\frac{\partial M_a^\star(M_c)}{\partial M_c}\right)^{-1}, \tag{5}$$

everywhere that both functions are differentiable. Appendix A contains the algebraic proof of (5), which depends only on consumers' costs of traveling abroad, β_a and β_c, being strictly positive for at least one country. Clearly, the possibility that the free entry equilibrium involves no entry in one or the other country exists. This would be the case if, for example, one country's stations enjoy significantly lower costs or a significantly larger "home market" of consumers. In what follows, we assume that both countries have active stations in the free entry equilibrium. This will be the case if both countries have equal costs and equal populations of consumers with identical preferences.

2.4 Exchange Rate Fluctuations

Our interest is in studying the responses of retail trade industries on the United States-Canada border to fluctuations in the two countries' nominal exchange rate. The impact of such fluctuations on the model industry clearly depends on how stations' input prices depend on the exchange rate and on the flexibility stations have in changing their output prices. For example, if we assume that r_a and r_cE are constant, so that all stations' costs denominated in \$US do not change, and stations on both sides of the border can change prices costlessly, then changes in E will not affect activity in either country's service station industry.

Non-neutrality of nominal exchange rate fluctuations can occur however if, for example, the costs of Canadian stations in \$C are "sticky" and respond only slowly to nominal exchange rate changes. This is the case if $\ln E$ and $\ln r_c$ are cointegrated but revert only slowly back to their long-run relationship. Because stations use a constant markup pricing rule, the price of gasoline in Canada relative to gasoline in the United States will fall if E rises, so consumers will substitute away from American service stations and towards Canadian service stations. Exchange rate fluctuations combined with sticky nominal costs will produce deviations from the law of one price. Goldberg (1995) assumes that nominal cost stickiness is the source of exchange rate non-neutrality in her analysis of automobile trade, and we follow her lead here.

How the two countries' industries accommodate a substitution by consumers away from one country's stations and towards the other's depends on how the speed with which service station entry and exit can change and on the constraints within stations on the adjustment of their operations. Consider first the extreme assumption that the above two-stage free entry game is repeated every year. In this case, an increase E that is not perfectly offset with a decrease in r_c will shift $M_a^\star(M_c)$ down and $M_c^\star(M_a)$ up. Figure 3 illustrates this by plotting the reaction curves before the exchange rate shock, the solid lines, and after the exchange rate shock, the dashed lines. The shock moves the free entry equilibrium from point 'A' to point 'B', decreasing M_a and increasing M_c. In the long run, the reaction curves will return to their original positions and the free entry equilibrium will return to 'A' if either E decreases or r_c increases so that Er_c returns to its original value. However, the exchange rate fluctuations will have no impact on the average size of establishments in either country, because the free entry condition must hold in each period and the profit per sale, denominated in domestic currencies, is constant, the quantity sold per station must also be constant for post–entry profits to be so. Therefore, each country's service station industry will adjust entirely by changing the number of active stations, leaving their sizes and internal operations unchanged. This extreme use of entry and exit to accommodate external shocks is familiar from competitive industry dynamics models, such as Caballero and Hammour (1994).

If the rate of entry cannot be increased costlessly, as in Caballero and Hammour's (1994) model with congestion effects, then individual stations will also adjust the scale of their activities. The starkest example of this comes from the case where entry requires time to build, so the number of stations in each country is fixed in the short run. Suppose then that the exchange rate appreciates, lowering the $US costs of Canadian service stations, changing the relative price of gasoline in the two countries, and inducing consumers to shift their purchases away from American stations. Because this shift must be accommodated entirely by existing stations, the sales of each American station falls while the sales of each Canadian station rises. In our model, the service stations in each country use a common technology with constant marginal costs, which presumes that adjusting a stations' scale of operations is costless. In this case, we expect to see all factors of production, including employment, change to produce a larger or smaller output. However, it is conceivable that service stations face costs of adjusting their factor inputs on some dimensions, such as employment, but not on others, such as hours worked or effort per hour. In that case, marginal cost will be increasing, so we expect an accompanying price increase to somewhat dampen, but not eliminate, the shift of purchases away from American stations. Such adjustment costs induce service stations to adjust their operations using primarily the most flexible margins available. Thus, if the cost of hiring or discharging employees is high, then service stations will adjust their output by changing the hours worked per employee or the effort per employee hour.

The model presented in this section and the discussion of a model without free entry suggest that retail industries may respond to movements in the real exchange rate in a variety of ways. The next section provides an empirical analysis of the response of U.S. retailers located close to the Canadian border to movements in the real exchange rate.

3 The Data

3.1 Econometric Methodology

Our empirical work seeks to characterize the responses of retail trade industries located near the United States-Canada border to fluctuations in the relative prices of goods in the two countries. To do so, we use annual observations of retail trade industries' employment, establishments with employees, and payroll in each county in each state that shares a land or bridge border with Canada. Our observations come from twenty years of the County Business Patterns (*CBP*) database, from 1977 until 1996. Because these data are based on payroll tax records, they contain no information on establishments without employees or on any establishments' sales. Therefore, if an industry's establishments accommodate short run fluctuations primarily by changing their employees' effort and do not contemporaneously reward that effort, our data will detect no industry response to the shock. We use data from all eight of the retail trade sector's two digit industries but one, SIC 55, Automobile Dealers and Service stations. Because the establishments composing that industry are particularly heterogeneous and the county business patterns has relatively complete data for its constituent three digit industries, we examine the three digit industries Auto and Home Supply Stores (SIC 553), Service Stations (SIC 554), and the remainder of SIC 55 separately.

The simple model shows how the relative price of the same good on different sides of a border can be plausibly thought of as "exogenous" to a particular industry when nominal costs are sticky and retailers rationally employ constant markup pricing rules. However, the simple model ignores the process that determines the nominal exchange rate. If monetary shocks in both countries affect both the nominal exchange rate and firms' costs, perhaps by changing the supply of credit, then the observed responses of retail industries near the border to exchange rate movements will reflect both the direct cost changes and the shifts of consumers' purchases across countries due to nominal price or cost stickiness. To disentangle the effects of consumer substitution between American and Canadian retailers from the direct effects of macroeconomic shocks on retail trade industries, we compare observations from counties on the United States-Canada border with those from counties off of that border. Our identifying assumption is that international consumer substitution only affects retail industries in counties that are geographically close to the United States-Canada border. We discuss plausible definitions of "geographically close" below.

The specific econometric model we estimate is a panel data vector autoregression in payroll, employment, and the number of establishments, all expressed in natural logarithms. For a given industry, let p_{it}, n_{it}, and m_{it} denote these three variables for county i during year t, let e_t denote the natural logarithm of the price of that industry's good in the United States relative to its price in Canada, let b_i denote a dummy variable that equals one if county i is close to the United States-Canada border, and let e_{it} denote the product of b_i and e_t. Then our three estimating equations are

$$p_{it} = \alpha_i^p + \delta_t^p + \lambda_p^p p_{it-1} + \lambda_n^p n_{it-1} + \lambda_m^p m_{it-1} + \beta_0^p e_{it} + \beta_1^p e_{it-1} + \varepsilon_{it}^p \quad (6)$$

$$n_{it} = \alpha_i^n + \delta_t^n + \lambda_p^n p_{it-1} + \lambda_n^n n_{it-1} + \lambda_m^n m_{it-1} + \beta_0^n e_{it} + \beta_1^n e_{it-1} + \varepsilon_{it}^n \quad (7)$$

$$m_{it} = \alpha_i^m + \delta_t^m + \lambda_p^m p_{it-1} + \lambda_n^m n_{it-1} + \lambda_m^m m_{it-1} + \beta_0^m e_{it} + \beta_1^m e_{it-1} + \varepsilon_{it}^m \quad (8)$$

The disturbances ε_{it}^p, ε_{it}^n, and ε_{it}^m are assumed to have conditional expectations equal to zero and be independent across time and across counties. The disturbances may, however, be correlated across equations. The fixed county specific effects, α_i^p, α_i^n, and α_i^m, account for permanent differences in the level of retail trade activity across counties, such as those that arise from population differences. The time specific effects, δ_t^p, δ_t^n, and δ_t^m, reflect macroeconomic shocks that impact retail trade in all counties proportionally, such as the cost effects of monetary shocks discussed above. The time effects will also capture any trends in these industries' variables that are common to all counties. The parameter β_0^p measures the elasticity of payroll in a county near the border to the relative price. The parameters β_0^n and β_0^m measure the analogous elasticities of employment and establishments. The parameters β_1^p, β_1^n, and β_1^m account for possible lagged effects of the relative price on industry variables.

To estimate this model, we first difference (6), (7), and (8) to eliminate the county specific effects. Estimation of the first differenced equations using ordinary least squares yields inconsistent estimates, because the lagged dependent variables, Δp_{it-1}, Δn_{it-1}, and Δm_{it-1} are correlated with the disturbances $\Delta\varepsilon_{it}^p$, $\Delta\varepsilon_{it}^n$, and $\Delta\varepsilon_{it}^m$. Anderson and Hsiao (1981) suggest estimating the first differenced equations instead using the differenced and twice lagged dependent variables, Δp_{it-2}, Δn_{it-2}, and Δm_{it-2}, as instrumental variables. We follow this suggestion and include the remaining dependent variables, e_{it}, e_{it-1}, and a set of time dummies, in the instrument set to achieve identification.

3.2 Observations of Retail Trade Industries

Our source of retail trade industry observations is the United States Census' annual publication, *County Business Patterns*. We construct our data set from twenty years of this publication from 1977 through 1996. For each retail trade industry, the *CBP* reports each county's total employment, establishment count, first quarter payroll, and annual payroll. In addition, the *CBP* reports the total number of establishments falling into several predetermined employment size classes. The establishment counts give the number of establishments that had paid employment at any time during the year, while the employment counts measure employment during a mid-March pay period. Because this data is based on administrative payroll tax records, its quality is very high. Nevertheless, the data have two shortcomings for our purposes.

First, establishments are assigned to a particular two or three digit industry only if that industry's definition encompasses most of that establishment's activities. This implies that establishment, employment, and payroll observations for a particular two-digit industry may be greater than the sums of those observations across its constituent three digit industries. Very few retail establishments are so diverse as to not be assigned a two-digit industry, and this problem is not very severe for SIC 55. Therefore, we confine our analysis to these industries. Second, the Census Bureau withholds the employment and payroll information for any county where that data may disclose information about any individual producer. The Census Bureau never withholds the establishment counts by size category. There is no precise rule that the Census uses to determine which observations must be withheld, but these disclosure cases tend to occur in counties with small populations and few establishments. For some counties, the census withholds data in almost every year of our sample period, while for others this only occurs occasionally. To produce a balanced panel of employment and payroll observations across counties, we estimate employment and payroll per establishment for establishments in each size category using state level data for all establishments in counties with withheld data. We replace the withheld employment and payroll observations with their forecast values using our estimates and the published establishment counts. Appendix B describes this data replacement procedure in greater detail.

The sample of all counties in states that border Canada range from very small counties, such as Divide County, North Dakota to very large, urban counties, such as Erie County, New York. Even given the county specific fixed effects in (6), (7), and (8), it is unrealistic to expect our simple parametric model to describe all of these counties' retail trade industry dynamics. For example, the specification of (8) is probably adequate for counties with large numbers of establishments, but the number of active establishments is probably better described by a dynamic count model in a small county with few producers. For this reason, we confine our analysis to counties with relatively large numbers of establishments using two selection criteria. First, we consider only counties with populations greater than 20,000 people, as measured in the 1990 decennial census. There are 256 such counties in the ten continental states that border Canada. Second, we drop all observations from any county-industry pair with ten or more observations withheld by the Census Bureau. This criterion lessens the dependence of our results on our data replacement procedure. As noted above, disclosure withholding primarily affects counties with few producers, so our resulting sample is of relatively unconcentrated industries in relatively populated counties.[1]

Our county selection criteria produce different samples for each industry we consider. Table 2 provides summary statistics for each industry's sample of counties. Its first column reports the number of counties included in each sam-

[1] Because our empirical model is specified in logarithms, it requires a sample of counties in which the industry always has at least one establishment with paid employment. Our two selection criteria eliminate all counties that ever report zero active establishments in the two-digit industries, but there are zero reported establishments in three counties for SIC 553, Auto and Home Supply Stores. We simply dropped those counties from our estimation for that industry.

ple, and its remaining three columns report the first quartile, median, and third quartile, across counties, of the average number of establishments, across years, serving that industry. None of the 256 counties with populations greater than 20,000 had ten or more of their establishment and payroll observations withheld for ten or more years in Food Stores (SIC 54), Service Stations (SIC 554), Eating and Drinking Places (SIC 58), and Miscellaneous Retail (SIC 59), so all 256 counties are in those industries samples. The data withholding criterion eliminates only two counties for Building Materials and Garden Supplies. For the remaining industries, it removes between 29 and 31 counties. The sample quartiles of average establishment counts indicate the extent to which our selection procedures leave relatively unconcentrated industries. For all industries but General Merchandise Stores and Auto and Home Supply Stores, the median county has more than twenty establishments in an average year. For those two industries, the median counties have 12.1 and 10.7 establishments. Their first quartiles equal 7.9 and 6.6, so they are quite concentrated in many of the sample counties. There are very few counties in which the remaining industries are this concentrated. With the exceptions of General Merchandise Stores and Auto and Home Supply Stores, the county selection procedure seems to have produced a sample of relatively unconcentrated industries.

Our data describe three margins along which an individual industry can vary its activity: payroll, employment, and establishments. To assess how these margins individually contribute to local retail trade industries' idiosyncratic fluctuations, we regressed each of these variables, in logarithms, against a set of time dummies. We then calculated the standard deviations of that regression's residuals for each county. Table 3 reports the medians, across counties, of these sample standard deviations for each retail trade industry. In practice, these medians are close to their corresponding means. Relative to many aggregate time series, these median standard deviations are quite high for all of the industries. The lowest median standard deviations are in Eating and Drinking Places, 0.13 for payroll, 0.12 for establishments, and 0.09 for establishments. The results for Food Stores are similar to those for Eating and Drinking Places, while the remaining industries display somewhat more variance. The industries with the most variation are Auto and Home Supply Stores, Apparel and Accessory Stores, and General Merchandise Stores. If producers in all counties pay the same wage to a homogeneous work force in any given year, then the idiosyncratic payroll fluctuations reflect changes in total hours worked. Surprisingly, the median standard deviations for payroll and employment are very close to each other for every industry, *suggesting* that much of the variation in hours worked is due to changes in total employment and not in hours worked per employee. For all industries, the median standard deviations of establishments are lower than those of payroll and employment, as we would expect if entry and exit take time to respond to shocks. However, these standard deviations are all more than two-thirds the size of the corresponding employment statistic, indicating that these industries' structures are far from rigid.

3.3 The Border

Determining which counties are "close to" the United States-Canada border is an essential step in identifying the effects of international consumer substitution on local retail trade industries, but there is no unambiguously correct way to do so. The willingness of consumers to substitute foreign for domestic purchases clearly depends on the nature of the good and their distance to foreign suppliers. For example, it makes little sense to travel to Canada to buy gasoline at a lower real price if one must consume much of the purchase in travel. In contrast, the acquisition of a light-weight and high value book or stereo system may justify an extended drive.

For this reason, we consider two mutually complementary methods of identifying counties that are close to the border. The first method is based on simple geographic contiguity. We identified a county as a "border" county if it contained a border crossing point, as indicated in the 1997 edition of the Rand McNally Standard Highway Mileage Guide. The resulting set of counties includes all of those that are geographically contiguous to Canada with the exceptions of Flathead County, Montana, St. Louis County and Lake County in

Minnesota and Oxford County, Maine. In addition, it includes Clallam County and Skagit County in Washington, which can be reached from Canada using regularly scheduled ferry service. This identifies 49 counties as border counties, but only 21 of these are in our sample of 256 counties with populations greater than 20,000. The elimination of counties from the sample due to frequent data suppression never reduces the number of geographically contiguous counties below 19. We refer to this definition of the border area as the "Geographic Definition."

Our second identification method is based on proximity to a significant population of Canadians. For this, we identify a county as a border county if it is within 75 miles of a Canadian Census Metropolitan Area (*CMA*). A *CMA* is defined as a very large urban area (known as the urban core) together with adjacent urban and rural areas that have a high degree of social and economic integration with the urban core. In addition, a *CMA* has an urban core population of at least 100,000 people. To calculate distance, we use the "great circle" or "as the crow flies" distance between "central points" within the counties and *CMA*'s. We refer to this definition of the border area as the "Population Proximity Definition." According to this definition based on population proximity, 56 counties are border counties. Of these, 38 are in our largest sample of 256 counties. No industry's sample has fewer than 34 such counties. In comparing these two methods of identifying border counties, the latter definition includes a number of counties in Michigan, New York, and Vermont which do not directly border Canada.

3.4 International Relative Prices

Our measures of international relative prices are based on aggregate price indices from the United States and Canada and the nominal exchange rate between the two countries. For each retail trade industry, we attempted to find matching consumer price indices from the two countries that matched the goods for sale by that industry as closely as possible. Some industries such as General Merchandise Stores and Miscellaneous Retail offer a wide variety of goods for sale. We constructed relative prices for those two industries using the aggregate consumer price indices for all goods less energy. We failed to find matching price indices for Building Materials and Garden Supplies, so we also use the aggregate relative price series for that industry. Table 4 lists the relative price series used in the estimation of (6), (7), and (8) for each industry and the U.S. and Canadian CPI series used in their construction.

The first two columns of Table 5 report the sample standard deviation and first autocorrelation for the industries' relative price series, expressed in logarithms. As the discussion in the introduction might suggest, the relative price of gasoline between the two countries has a large standard deviation, 0.203. Most of this variance reflects fluctuations in the years of the Canadian National Energy Policy (NEP). In response to international oil price shocks in the 1970's, the Canadian federal government implemented the NEP which, among other things, imposed import subsidies and export taxes on petroleum products. Thus while gasoline prices rose considerably in the U.S. in response to these shocks, Canadian gasoline prices did not and the relative price of gasoline between the two countries exhibited considerable fluctuation. The standard deviations for the remaining relative price series are all between 0.06 and 0.09.

Unsurprisingly, the relative price series are all highly persistent, with first order autocorrelations between 0.74 and 0.87. Table 5's final column reports the contemporaneous correlation between each industry's relative price series and that constructed with the aggregate CPI's for all goods less energy. The largest correlation among the industries with narrower relative price series is 0.68, for Eating and Drinking Places. The lowest is -0.08, for Service Stations. Thus, it appears that the relative prices of individual retail trade industries can differ considerably from the "aggregate" real exchange rate.

4 Results

We first focus on the results for a particular retail industry, Service Stations (SIC 554) using the geographic identification of border counties. We expect this definition of border counties to be more relevant for Service Stations than the population proximity definition as consumers will be unwilling to travel long distances to purchase gasoline. Table 6 provides coefficient estimates for this industry for all explanatory variables except time dummies for each regression contained in equations 6 - 8. The results indicate that employment and establishments are relatively persistent. Coefficient estimates for the current gasoline real exchange rate are close to zero and insignificant while coefficient estimates for lagged gasoline real exchange rates are negative and significant. These results suggest that when the price of gasoline in the U.S. falls relative to Canada (a fall in the gasoline real exchange rate) that U.S. service stations located near the Canadian border increase their employee's hours, increase their employment, and new service stations enter the industry with a lag. Thus, this industry appears to respond to increases in demand both by increased output per firm and by increases in the number of firms operating in the industry, although the latter is much more quantitatively significant than the former.

Table 7 reports the results of separate Wald tests for excluding lagged dependent variables and for excluding gasoline real exchange rates. As the coefficient estimates suggest, the Wald tests indicate that the lagged dependent variables are jointly significant for employment and establishments but not for payroll. Also given the results contained in Table 6 it is not surprising that these results indicate that current and lagged relative gasoline prices are jointly significant.

We now turn to regression results for all the retail industries in our sample, focusing on the effects of real exchange rates on the three variables of interest. Table 8 presents coefficient estimates for current and lagged real exchange rates using the geographic definition of border counties. In addition, Table 9 gives the results of Wald tests for joint significance of current and lagged relative prices. Of the 60 coefficient estimates contained in that Table, 38 are of the expected sign (negative) and of those, 12 are significant at the 10% level. For the payroll regressions, those industries for which coefficient estimates on either current or lagged relative prices are negative and significant include Food Stores, Service Stations, Auto Dealers, Eating and Drinking Places, and Miscellaneous Retail. For the employment regressions, General Merchandise Stores, Service Stations, Auto Dealers, Eating and Drinking Places, and Miscellaneous Retail all exhibit this property while only Service Stations and Miscellaneous Retail have negative and significant coefficient estimates for establishments.

That we find significant effects in Food Stores and Service Stations is not surprising given the results of survey data by Jokinen (1990), Ford (1992), Winter (1990) and others. Ford's data for western New York suggest that groceries and gasoline are two of the three most frequently given reasons for cross-border shopping by Canadians. Jokinen and Winter also argue that Canadians (within a certain distance of the border) shopped weekly for gasoline and groceries and less frequently for other items. Our results suggest that Food Stores respond to changes in demand primarily by adjusting hours (and, perhaps employee effort, which we do not measure), but not through entry and exit. In contrast, as discussed above Service Stations appear to adjust along all three margins that we measure. This may reflect the time necessary to build new grocery stores is much longer than that required to build new service stations.

The significant effects in miscellaneous retail are also not surprising when we consider that items such as books, cameras, jewelry, liquor, toys, and cosmetics are included in that category. Our results suggest that stores selling these types of items respond with a lag to changes in the real exchange rate through both changes in output per firm and through entry and exit. Finally, our prior was that we would find significant effects in the restaurant industry along the three dimensions that we measure and our results are consistent with those priors.

A result that is surprising is that we do not find significant effects for Apparel and Accessory Stores. According to the data collected by Ford (1992), clothing is as important of a purchase as groceries and gasoline for Canadian cross-border shoppers, yet we do not find significant effects of movements in the relative price of clothing on any of the variables we measure. We hypothesize that this industry is responding to changes in demand primarily through employee effort. We speculate that if U.S. county sales data were available, we would see that this industry's sales rose in response to a fall in the relative price of clothing in the U.S.

Another surprising result is that we do not find significant effects for Furnishings when we use a relative price series constructed using price indexes for furnishings as the explanatory variable but we do find effects when we use an aggregate relative price series. In particular, when we use the relative price series constructed using consumer prices for all goods less energy, we find negative coefficients on lagged relative prices which are significant at the 10% level for both payroll and employment. Upon investigating this further, we discovered that this industry includes electronic equipment such as computers, stereo systems, and televisions (which should be subject to cross-border shopping) as well as furniture (which we would expect to be less vulnerable to cross-border shopping). In contrast, the Canadian price index labeled Household Furnishings that we used to construct the relative price series for this industry does not include electronic items. They are included in a price series labeled Recreation. The U.S. series we used, however, includes both furniture and electronics. This suggests that the relative price series we used for this industry is not a good proxy for this industry because this industry is quite diverse. It would certainly be worthwhile to use three digit level data for this industry and this is planned for future work.

Turning to General Merchandise Stores, the large standard errors for the estimates in this industry indicate that the coefficient estimates are not very precise. This may be a result of the fact that we did not have a relative price that was specific for this industry available and, instead, used the real exchange rate constructed using price indexes for all goods less energy as our measure of the relative price for this industry. This result along with the result for Furnishings described above suggest that it is important to have an appropriate measure of the relative price series which are specific to an industry.

In any case, the results contained in these two tables suggest that retailers located in U.S. counties which are along the Canadian border respond differently to movements in real exchange rate according to their industry. Perhaps this reflects differences in the ease with which industries can respond to relative price movements with regard to hiring and firing workers, flexibility of workers' hours, and entering and exiting the industry.

Tables 10 and 11 report the same variables as the previous two tables but for regressions in which counties identified as border counties are those which are located within 75 miles of a Canadian Census Metropolitan Area. For these regressions, 33 coefficients are negative and 3 of those are significant at the 10% level. Furthermore, the Wald tests indicate joint significance of current and lagged relative prices only for payroll for Food Stores and for Employment for Food Stores and Restaurants. Comparing these results with the results from the previous regressions in which the border was defined by geographic proximity, it suggests that most of the effects of cross-border shopping are felt very close to the border. This may suggest that our first definition of the border "correctly" identified those counties which are open to cross-border shopping. We are currently examining results when the border is defined using a 50 mile criterion rather than a 75 mile criterion.

5 Conclusion and Extensions

This paper has focused on the effects of movements in relative prices between the U.S. and Canada on payroll, employment, and the number of establishments in retail industries located near the border. The empirical results indicate that movements in these relative prices have real effects on these industries and that these effects vary considerably across industries. These results suggest, among other things, that it is important to gain an understanding of the forces which lead to movements in international relative prices, that models of industry dynamics should consider industry characteristics in their modeling approach, and that this data set is promising for testing the implications of those models for an industry's response to demand shocks.

Future work includes using additional three digit level data and using relative price series which better match the industry under study. We are also investigating Canadian sales and establishment data grouped according the first three digits of the postal code to determine effects on Canadian retailers. We plan to expand the theoretical model and provide a richer environment for analyzing the effects of real and nominal exchange rate movements on retail industries. This data will also provide an empirical base for evaluating the predictions of that and other models of industry dynamics.

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A Uniqueness of Free Entry Equilibrium

This appendix proves the uniqueness of a free entry equilibrium in the model of Section 2. Recall that the free entry reaction functions, $M_a^\star(M_c)$ and $M_c^\star(M_a)$, satisfy

$$\pi_a\left(M_a^\star(M_c), M_c\right) = F_a$$
$$\pi_c\left(M_a, M_c^\star(M_a)\right) = F_c.$$

That is, $M_a^\star(M_c)$ is the number of active stations in the United States that is consistent with free entry given M_c stations operating in Canada, and $M_c^\star(M_a)$ is the number of active stations in Canada that is consistent with free entry given M_a stations operating in the United States. A free entry equilibrium is defined as a pair (M_a, M_c) such that $M_a = M_a^\star(M_c)$ and $M_c = M_c^\star(M_a)$.

Proposition 1 *The reaction functions $M_a^\star(M_c)$ and $M_c^\star(M_a)$ are both differentiable and satisfy*

$$\frac{\partial M_c^\star(M_a)}{\partial M_a} > \left(\frac{\partial M_a^\star(M_c)}{\partial M_c}\right)^{-1}.$$

Proof: Let π_a^i and π_c^i be the derivatives of π_a and π_c with respect to their i'th arguments. The implicit function theorem implies that

$$\frac{\partial M_c^\star(M_a)}{\partial M_a} = \frac{-\pi_c^1}{\pi_c^2}$$
$$\frac{\partial M_a^\star(M_c)}{\partial M_c} = \frac{-\pi_a^2}{\pi_a^1},$$

so the reaction functions are both differentiable. The inequality in the proposition is satisfied if and only if

$$\pi_a^1\pi_c^2 > \pi_a^2\pi_c^1.$$

The two post-entry profit functions, written as explicit functions of the models parameters, are

$$
\begin{aligned}
\pi_a(M_a, M_c) = & \left[p_a^\eta \frac{N_a \exp(-\alpha_a)}{1 + M_a \exp(-\alpha_a - \eta \ln p_a) + M_c \exp(-\alpha_a - \beta_a - \eta \ln p_c)} \right. \\
& \left. + p_a^\eta \frac{N_c \exp(-\alpha_c - \beta_c)}{1 + M_a \exp(-\alpha_c - \beta_c - \eta \ln p_a) + M_c \exp(-\alpha_c - \eta \ln p_c)} \right] \\
& \times (p_a - r_a) \\
\pi_c(M_a, M_c) = & \left[p_c^\eta \frac{N_a \exp(-\alpha_a - \beta_a)}{1 + M_a \exp(-\alpha_a - \eta \ln p_a) + M_c \exp(-\alpha_a - \beta_a - \eta \ln p_c)} \right. \\
& \left. + p_c^\eta \frac{N_c \exp(-\alpha_c)}{1 + M_a \exp(-\alpha_c - \beta_c - \eta \ln p_a) + M_c \exp(-\alpha_c - \eta \ln p_c)} \right] \\
& \times (p_c - r_c).
\end{aligned}
$$

Define the following constants:

$$
\begin{aligned}
\lambda^{aa} &= \exp(-\alpha_a) \\
\lambda^{ac} &= \exp(-\alpha_c - \beta_c) \\
\lambda^{ca} &= \exp(-\alpha_a - \beta_a) \\
\lambda^{cc} &= \exp(-\alpha_c) \\
\theta^{aa} &= \exp(-\alpha_a - \eta \ln p_a) \\
\theta^{ac} &= \exp(-\alpha_a - \beta_a - \eta \ln p_c) \\
\theta^{ca} &= \exp(-\alpha_c - \beta_c - \eta \ln p_a) \\
\theta^{cc} &= \exp(-\alpha_c - \eta \ln p_c). \\
C^a &= (p_a - r_a) p_a^\eta \\
C^c &= (p_c - r_c) p_c^\eta
\end{aligned}
$$

The two profit functions can then be more compactly written as

$$
\begin{aligned}
\pi_a(M_a, M_c) &= C^a \left(\frac{\lambda^{aa} N_a}{1 + M_a \theta^{aa} + M_c \theta^{ac}} + \frac{\lambda^{ac} N_c}{1 + M_a \theta^{ca} + M_c \theta^{cc}} \right) \\
\pi_c(M_a, M_c) &= C^c \left(\frac{\lambda^{ca} N_a}{1 + M_a \theta^{aa} + M_c \theta^{ac}} + \frac{\lambda^{cc} N_c}{1 + M_a \theta^{ca} + M_c \theta^{cc}} \right).
\end{aligned}
$$

Taking derivatives of these functions with respect to M_a and M_c, we get

$$\pi_a^1 = -C^a \left(\frac{\lambda^{aa} N_a \theta^{aa}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2} + \frac{\lambda^{ac} N_c \theta^{ca}}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right)$$

$$\pi_a^2 = -C^a \left(\frac{\lambda^{aa} N_a \theta^{ac}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2} + \frac{\lambda^{ac} N_c \theta^{cc}}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right)$$

$$\pi_c^1 = -C^c \left(\frac{\lambda^{ca} N_a \theta^{aa}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2} + \frac{\lambda^{cc} N_c \theta^{ca}}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right)$$

$$\pi_c^2 = -C^c \left(\frac{\lambda^{ca} N_a \theta^{ac}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2} + \frac{\lambda^{cc} N_c \theta^{cc}}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right).$$

The relevant products of these derivatives are

$$\pi_a^1\pi_c^2 = C^a C^c \left(\frac{\lambda^{aa} N_a \theta^{aa}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2} + \frac{\lambda^{ac} N_c \theta^{ca}}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right)$$
$$\times \left(\frac{\lambda^{ca} N_a \theta^{ac}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2} + \frac{\lambda^{cc} N_c \theta^{cc}}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right)$$

$$\pi_a^2\pi_c^1 = C^a C^c \left(\frac{\lambda^{aa} N_a \theta^{ac}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2} + \frac{\lambda^{ac} N_c \theta^{cc}}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right)$$
$$\times \left(\frac{\lambda^{ca} N_a \theta^{aa}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2} + \frac{\lambda^{cc} N_c \theta^{ca}}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right).$$

Expanding these products yields

$$\pi_a^1\pi_c^2 = C^a C^c \left(\frac{\lambda^{aa}\lambda^{ca}\theta^{aa}\theta^{ac} N_a^2}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^4} + \frac{\lambda^{ac}\lambda^{cc}\theta^{ca}\theta^{cc} N_c^2}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^4} \right.$$
$$\left. + N_a N_c \frac{\lambda^{aa}\lambda^{cc}\theta^{aa}\theta^{cc} + \lambda^{ac}\lambda^{ca}\theta^{ca}\theta^{ac}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2 (1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right)$$

$$\pi_a^2\pi_c^1 = C^a C^c \left(\frac{\lambda^{aa}\lambda^{ca}\theta^{aa}\theta^{ac} N_a^2}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^4} + \frac{\lambda^{ac}\lambda^{cc}\theta^{ca}\theta^{cc} N_c^2}{(1 + M_a\theta^{ca} + M_c\theta^{cc})^4} \right.$$
$$\left. + N_a N_c \frac{\lambda^{aa}\lambda^{cc}\theta^{ac}\theta^{ca} + \lambda^{ac}\lambda^{ca}\theta^{cc}\theta^{aa}}{(1 + M_a\theta^{aa} + M_c\theta^{ac})^2 (1 + M_a\theta^{ca} + M_c\theta^{cc})^2} \right).$$

The first two terms in the first expression are identical to the corresponding terms in the second. Therefore, the proposition's inequality will be satisfied if and only if

$$\lambda^{aa}\lambda^{cc}\theta^{aa}\theta^{cc} + \lambda^{ac}\lambda^{ca}\theta^{ca}\theta^{ac} > \lambda^{aa}\lambda^{cc}\theta^{ac}\theta^{ca} + \lambda^{ac}\lambda^{ca}\theta^{cc}\theta^{aa}.$$

Gathering terms on the left hand side, this can be simplified to

$$\left(\lambda^{aa}\lambda^{cc} - \lambda^{ac}\lambda^{ca}\right)\left(\theta^{aa}\theta^{cc} - \theta^{ac}\theta^{ca}\right) > 0.$$

Using these constants' definitions, we can see that

$$\begin{aligned}
\lambda^{aa}\lambda^{cc} - \lambda^{ac}\lambda^{ca} &= \exp\left(-\alpha_a - \alpha_c\right)\left(1 - \exp\left(-\beta_a - \beta_c\right)\right) \\
\theta^{aa}\theta^{cc} - \theta^{ac}\theta^{ca} &= \exp\left(-\alpha_a - \alpha_c - \eta \ln p_a - \eta \ln p_c\right)\left(1 - \exp\left(-\beta_a - \beta_c\right)\right).
\end{aligned}$$

Both of these terms are positive if either $\beta_a > 0$ or $\beta_c > 0$, which we have assumed to be the case.

B Data Replacement Procedure

This appendix describes a simple procedure for replacing payroll and employment data for retail trade industries in the County Business Patterns data set that has been withheld by the Census to preserve confidentiality. The basic idea is to use the information that we do have on establishment counts by size class at the county level and total employment and payroll at the state level to estimate the relationship between the number of establishments and total employment and payroll among those counties where the data has been withheld. Fitted values from these estimated regressions then serve as unbiased estimates of the withheld data. For clarity, we focus below on replacing the withheld employment data. The procedure for replacing payroll data is identical.

To begin, consider a particular two digit retail trade industry during a particular year. Let N_c^s denote the total employment in that industry in county c of state s, and let N^s denote the statewide employment in that industry for state s. If $C(s)$ is the set of all counties in state s, then

$$N^s = \sum_{c \in C(s)} N_c^s.$$

We assume that observations of N^s are available for every state. Because the number of retail establishments in a given state is usually large, data suppression is typically not a problem at the state level in this data set. On the other hand, suppression of observations of N_c^s for individual counties is common. What is always reported for each county is the number of establishments belonging to several predetermined size classes. Let J denote the set of such size classes and $M_c^s(j)$ denote the number of establishments in class j in county c of state s. The data replacement procedure is based on a regression model of N_c^s on $M_c^s(j)$ restricted to those counties where the census has withheld publication of N_c^s. Let W^s denote the set of all counties in state s for which the Census has withheld publication of N_c^s. Then the basic regression model is

$$N_c^s = \sum_{j \in J} \beta_j M_c^s(j) + u_c^s \tag{9}$$
$$\mathbf{E}[u_c^s] = 0$$

for all $c \in W^s$. The coefficients β_j are constant across both counties and states. That is, the regression equation specifies that the total number of employees in a county equals a linear function of the number of establishments in each size class plus a mean zero error term.

The obvious impediment to estimating the equation is that the dependent variable is withheld for all of the observations of interest. To overcome this, we can aggregate the equation to the state level, where the aggregated dependent variable is observable. To do so, define $\widetilde{N}^s$ as the employment in all counties in state s for which employment data is withheld. This can be constructed as statewide employment minus employment at all counties at which employment was reported. That is

$$\widetilde{N}^s = N^s - \sum_{c \in \overline{W}^s} N_c^s,$$

where $\overline{W}^s$ is the complement of W^s. If we then define

$$\widetilde{M}^s(j) = \sum_{c = W^s} M_c^s(j)$$

then aggregating Equation 9 for state s yields

$$\widetilde{N}^s = \sum_{j \in J} \beta_j \widetilde{M}^s(j) + \widetilde{u}^s, \tag{10}$$

where

$$\widetilde{u}^s = \sum_{c = W^s} u_c^s.$$

If we calculate the dependent variables and regressors for Equation 10 for each state, then the coefficients β_j can be estimated by applying the regression to the state level data. The fitted values of this estimated model can then be used to construct estimates of the withheld county level employment data.

Table 1: Spearman Rank Correlation Coefficients Between Real Exchange Rates and Number of Trips

Region	U.S. Auto Same Day Trips	Canadian Auto Same Day Trips
Canada	.49*	-.72*
Alberta	.22	-.48*
British Columbia	.40*	-.79*
Manitoba	.07	-.56*
New Brunswick	.16	-.64*
Ontario	.47*	-.69*
Quebec	.30	-.60*
Saskatchewan	-.02	-.68*

Notes: The entries are Spearman rank correlation coefficients between the real exchange rate constructed using aggregate consumer price indexes (Canadian goods per U.S. good) and the trip variable described in the column heading using annual data from 1972-1998. The superscript * denotes that the coefficient is significant at the 5% level.

Table 2: Quartiles from Sample Counties of Average Establishment Counts

Industry	Counties in Sample	First Quartile	Median	Third Quartile
Building Materials and Garden Supplies	254	16.6	24.7	39.7
General Merchandise Stores	227	7.9	12.1	21.8
Food Stores	256	26.7	45.0	93.3
Auto and Home Supply Stores	225	6.6	10.7	19.9
Service Stations	256	18.9	28.8	51.2
Auto Dealers	224	13.3	21.3	37.7
Apparel and Accessory Stores	228	16.2	28.2	68.5
Furniture and Home Furnishings Stores	227	13.3	24.4	54.2
Eating and Drinking Places	256	55.1	96.3	188.0
Miscellaneous Retail	256	42.8	73.5	150.6

Notes: 'Counties in Sample' refers to the number of counties included in the estimation sample for each industry. For each included county, the average number of establishments serving each industry between 1977 and 1996 was calculated. 'First Quartile', 'Median', and 'Third Quartile' refer to the quartiles of that statistic across all sample counties for that industry. See the text for further details.

Table 3: Median Within-County Standard Deviations

Industry	Payroll	Employment	Establishments
Building Materials and Garden Supplies	0.22	0.18	0.13
General Merchandise Stores	0.23	0.22	0.17
Food Stores	0.13	0.12	0.11
Auto and Home Supply Stores	0.27	0.24	0.19
Service Stations	0.19	0.18	0.13
Auto Dealers	0.16	0.13	0.13
Apparel and Accessory Stores	0.25	0.22	0.16
Furniture and Home Furnishings Stores	0.22	0.19	0.15
Eating and Drinking Places	0.13	0.11	0.09
Miscellaneous Retail	0.15	0.12	0.10

Notes: For each industry, each of the variables was first logged and regressed against a set of time dummies. The standard deviations of the residuals from that regression was computed for each county. The values reported in the table are the medians, across counties, of these statistics. See the text for further details.

Table 4: Consumer Price Index Sources for Relative Price Series

Industry	U.S. CPI	Canadian CPI
Building Materials and Garden Supplies	All Items Less Energy	All Items Excluding Energy
General Merchandise Stores	All Items Less Energy	All Items Excluding Energy
Food Stores	Food at Home	Food Purchased from Stores
Auto and Home Supply Stores	Transportation	Transportation
Service Stations	Gasoline	Gasoline
Auto Dealers	Transportation	Transportation
Apparel and Accessory Stores	Apparel and Upkeep	Clothing and Footwear
Furniture and Home Furnishings Stores	Household Furnishings and Operation	Household Furnishings
Eating and Drinking Places	Food Away from Home	Food Purchased from Restaurants
Miscellaneous Retail	All Items Less Energy	All Items Excluding Energy

Notes: For each industry, the column headed U.S. CPI reports the name of the consumer price index series used in constructing the relative price, and the column headed Canadian CPI reports the name of the analogous Canadian series. See the text for further details.

Table 5: Summary Statistics for Relative Price Series

Industry	Standard Deviation	First Autocorrelation	Correlation with Aggregate Real Exchange Rate
Building Materials and Garden Supplies	0.087	0.83	1.00
General Merchandise Stores	0.087	0.83	1.00
Food Stores	0.075	0.87	0.51
Auto and Home Supply Stores	0.078	0.83	0.25
Service Stations	0.203	0.85	-0.08
Auto Dealers	0.078	0.83	0.25
Apparel and Accessory Stores	0.064	0.74	0.36
Furniture and Home Furnishings Stores	0.076	0.80	0.59
Eating and Drinking Places	0.070	0.75	0.68
Miscellaneous Retail	0.087	0.83	1.00

Notes: The first two columns report the standard deviation and first autocorrelation of the relative price series used for the corresponding industry over the sample period 1977-1996. The final column gives the contemporaneous correlation between the relative price series and the relative price of "all goods less energy". See the text for further details.

Table 6: Coefficient Estimates for Service Stations

Coefficient on	Dependent Variable Payroll	Employment	Establishments
Lagged Payroll	0.11	-0.06	-0.10^{*}
	(0.11)	(0.11)	(0.06)
Lagged Employment	-0.01	0.20^{**}	0.04
	(0.09)	(0.10)	(0.07)
Lagged Establishments	0.21	0.30	0.39^{**}
	(0.18)	(0.19)	(0.14)
Current Relative Price	0.00	-0.04	-0.01
	(0.13)	(0.13)	(0.09)
Lagged Relative Price	-0.18^{**}	-0.14^{*}	-0.13^{*}
	(0.08)	(0.07)	(0.08)

Notes: The superscripts ** and * on the coefficient estimates indicate significance at the 0.05 and 0.10 levels. Standard errors that are robust to heteroskedasticity across counties and time are reported in parentheses below each coefficient estimate. The regressions use the geographic identification of border counties. See the text for further details.

Table 7: Wald Tests of Variable Exclusion for Service Stations

Wald Test Excluding	Dependent Variable Payroll	Employment	Establishments
Lagged Dependent Variables	0.76	2.78	3.27
	(0.51)	(0.04)	(0.02)
Relative Prices	3.39	2.65	3.58
	(0.04)	(0.07)	(0.03)

Notes: The Wald statistics are asymptotically distributed as χ^2 random variables with three degrees of freedom for the exclusion test on the lagged dependent variables and two degrees of freedom for the exclusion tests on the relative prices. The regressions use the geographic identification of border counties. See the text for further details.

Table 8: Coefficient Estimates using Geographic Border Definition

Industry	Payroll β_0^p	Payroll β_1^p	Employment β_0^n	Employment β_1^n	Establishments β_0^m	Establishments β_1^m
Building Materials	0.06	-0.40	0.09	-0.18	-0.05	0.00
and Garden Supplies	(0.21)	(0.25)	(0.20)	(0.22)	(0.17)	(0.17)
General Merchandise	0.79*	-0.40	0.78*	−0.55*	0.41*	-0.28
Stores	(0.42)	(0.26)	(0.40)	(0.28)	(0.17)	(0.22)
Food Stores	-0.03	−0.32**	-0.02	-0.29	-0.11	0.11
	(0.16)	(0.16)	(0.20)	(0.19)	(0.11)	(0.12)
Auto and Home	0.01	-0.07	0.29	-0.10	0.35	-0.25
Supply Stores	(0.57)	(0.45)	(0.44)	(0.38)	(0.24)	(0.22)
Service Stations	0.00	−0.18**	-0.04	−0.14*	-0.01	−0.13*
	(0.13)	(0.08)	(0.13)	(0.07)	(0.09)	(0.08)
Auto Dealers	−0.39**	0.34*	−0.21*	0.10	0.14	-0.11
	(0.19)	(0.18)	(0.12)	(0.14)	(0.15)	(0.13)
Apparel and	0.35	-0.66	0.39	-0.48	-0.01	0.05
Accessory Stores	(0.52)	(0.49)	(0.41)	(0.39)	(0.32)	(0.31)
Furniture and	-0.03	-0.16	-0.34	0.04	0.01	-0.21
Home Furnishings Stores	(0.38)	(0.37)	(0.32)	(0.30)	(0.18)	(0.18)
Eating and	-0.08	−0.28**	0.11	−0.41**	-0.09	-0.12
Drinking Places	(0.12)	(0.12)	(0.13)	(0.11)	(0.09)	(0.10)
Miscellaneous Retail	0.35	−0.54**	0.01	−0.30*	-0.01	−0.17**
	(0.26)	(0.25)	(0.18)	(0.17)	(0.11)	(0.08)

Notes: The headings β_0^p, β_1^p, β_0^n, etc. refer to the coefficients on the current and lagged international relative prices in (6), (7) and (8). The superscripts ** and * on the coefficient estimates indicate significance at the 0.05 and 0.10 levels. Standard errors that are robust to heteroskedasticity across counties and time are reported in parentheses below each coefficient estimate. The regressions use the geographic identification of border counties. See the text for further details.

Table 9: Wald Tests using Geographic Border Definition

Industry	Dependent Variable Payroll	 Employment	 Establishments
Building Materials and Garden Supplies	2.06 (0.13)	0.40 (0.67)	0.14 (0.87)
General Merchandise Stores	2.17 (0.12)	2.41 (0.09)	2.95 (0.05)
Food Stores	4.67 (0.01)	5.58 (0.00)	0.54 (0.58)
Auto and Home Supply Stores	0.02 (0.98)	0.23 (0.79)	1.23 (0.29)
Service Stations	3.39 (0.03)	2.65 (0.07)	3.58 (0.03)
Auto Dealers	2.21 (0.11)	1.53 (0.22)	0.47 (0.63)
Apparel and Accessory Stores	0.95 (0.39)	0.97 (0.38)	0.02 (0.99)
Furniture and Home Furnishings Stores	0.20 (0.82)	0.92 (0.40)	1.34 (0.26)
Eating and Drinking Places	3.98 (0.02)	7.28 (0.00)	3.34 (0.04)
Miscellaneous Retail	2.61 (0.08)	3.35 (0.04)	9.44 (0.00)

Notes: These tests are for variable exclusion of both current and lagged relative prices. The Wald statistics are asymptotically distributed as χ^2 random variables with two degrees of freedom. Probability values appear below each statistic in parentheses. The regressions use the geographic identification of border counties. See the text for further details.

Table 10: Coefficient Estimates using Population Proximity Border Definition

Industry	Payroll β_0^p	Payroll β_1^p	Employment β_0^n	Employment β_1^n	Establishments β_0^m	Establishments β_1^m
Building Materials and Garden Supplies	-0.31	0.10	-0.17	-0.01	-0.06	-0.01
	(0.20)	(0.21)	(0.14)	(0.14)	(0.11)	(0.11)
General Merchandise Stores	0.01	0.27	0.24	-0.15	0.24	-0.22
	(0.33)	(0.35)	(0.27)	(0.28)	(0.16)	(0.15)
Food Stores	0.05	-0.31^{**}	0.25^{*}	-0.38^{**}	0.00	-0.03
	(0.14)	(0.14)	(0.14)	(0.14)	(0.09)	(0.11)
Auto and Home Supply Stores	-0.41	0.04	-0.15	0.01	0.15	-0.05
	(0.39)	(0.30)	(0.31)	(0.28)	(0.20)	(0.16)
Service Stations	0.00	-0.11	0.00	-0.12	0.00	-0.04
	(0.11)	(0.09)	(0.14)	(0.14)	(0.08)	(0.06)
Auto Dealers	0.03	-0.09	0.12	-0.19	0.15	-0.01
	(0.14)	(0.13)	(0.10)	(0.11)	(0.11)	(0.10)
Apparel and Accessory Stores	-0.18	-0.08	0.18	-0.34	-0.01	0.03
	(0.37)	(0.48)	(0.28)	(0.37)	(0.18)	(0.23)
Furniture and Home Furnishings Stores	-0.10	0.32	-0.22	0.30	-0.03	-0.02
	(0.32)	(0.26)	(0.22)	(0.19)	(0.17)	(0.14)
Eating and Drinking Places	0.00	-0.16	0.08	-0.22^{**}	-0.03	-0.08
	(0.09)	(0.12)	(0.08)	(0.09)	(0.06)	(0.06)
Miscellaneous Retail	0.05	0.00	-0.02	-0.06	-0.08	0.01
	(0.17)	(0.21)	(0.14)	(0.12)	(0.08)	(0.08)

Notes: The headings β_0^p, β_1^p, β_0^n, etc. refer to the coefficients on the current and lagged international relative prices in (6), (7) and (8). The superscripts ** and * on the coefficient estimates indicate significance at the 0.05 and 0.10 levels. Standard errors that are robust to heteroskedasticity across counties and time are reported in parentheses below each coefficient estimate. The regressions use the population proximity identification of border counties. See the text for further details.

Table 11: Wald Tests using Population Proximity Border Definition

Industry	Payroll	Employment	Establishments
	Dependent Variable		
Building Materials and Garden Supplies	2.07 (0.13)	1.73 (0.18)	0.45 (0.64)
General Merchandise Stores	.76 (0.47)	.41 (0.67)	1.18 (0.34)
Food Stores	4.63 (0.01)	4.05 (0.02)	0.54 (0.58)
Auto and Home Supply Stores	0.70 (0.50)	0.17 (0.84)	.26 (0.77)
Service Stations	1.46 (0.23)	1.83 (0.16)	.65 (0.52)
Auto Dealers	.20 (0.82)	1.36 (0.26)	1.84 (0.16)
Apparel and Accessory Stores	0.24 (0.79)	0.45 (0.38)	0.01 (0.99)
Furniture and Home Furnishings Stores	1.11 (0.33)	1.28 (0.28)	.07 (0.93)
Eating and Drinking Places	1.51 (0.22)	3.28 (0.04)	2.08 (0.13)
Miscellaneous Retail	.06 (0.94)	.35 (0.70)	1.12 (0.33)

Notes: These tests are for variable exclusion of both current and lagged relative prices. The Wald statistics are asymptotically distributed as χ^2 random variables with two degrees of freedom. Probability values appear below each statistic in parentheses. The regressions use the population proximity identification of border counties. See the text for further details.

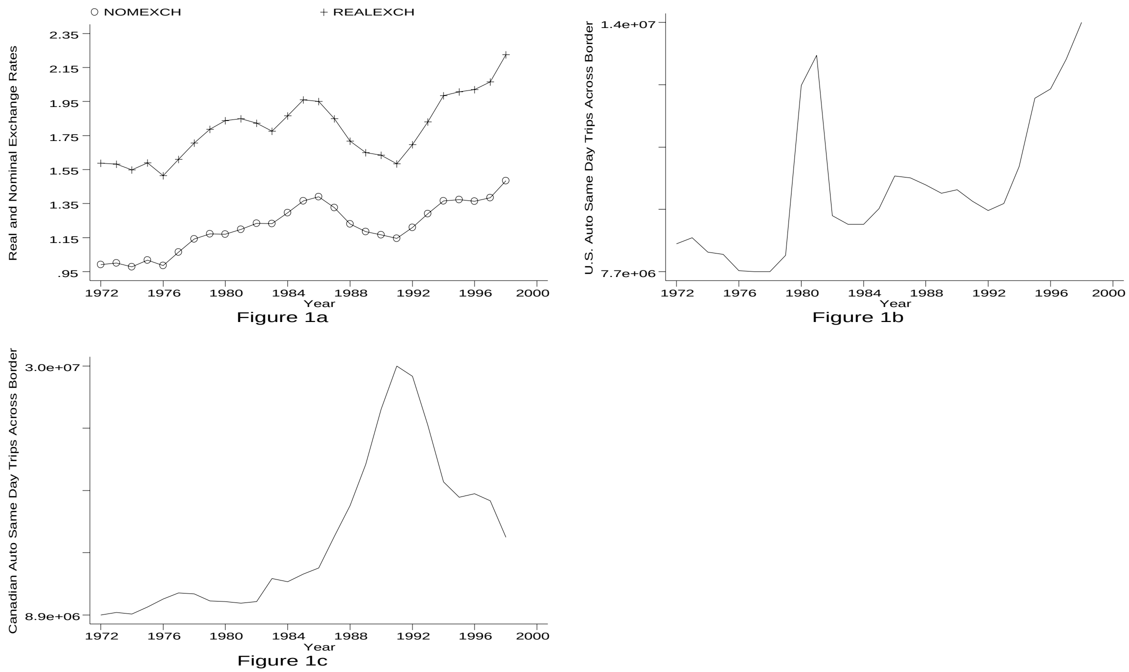
NOMEXCH
REALEXCH
Real and Nominal Exchange Rates
2.35
2.15
1.95
1.75
1.55
1.35
1.15
.95
1972 1976 1980 1984 1988 1992 1996 2000
Year
Figure 1a
U.S. Auto Same Day Trips Across Border
1.4e+07
7.7e+06
1972 1976 1980 1984 1988 1992 1996 2000
Year
Figure 1b
Canadian Auto Same Day Trips Across Border
3.0e+07
8.9e+06
1972 1976 1980 1984 1988 1992 1996 2000
Year
Figure 1c

Figure 1

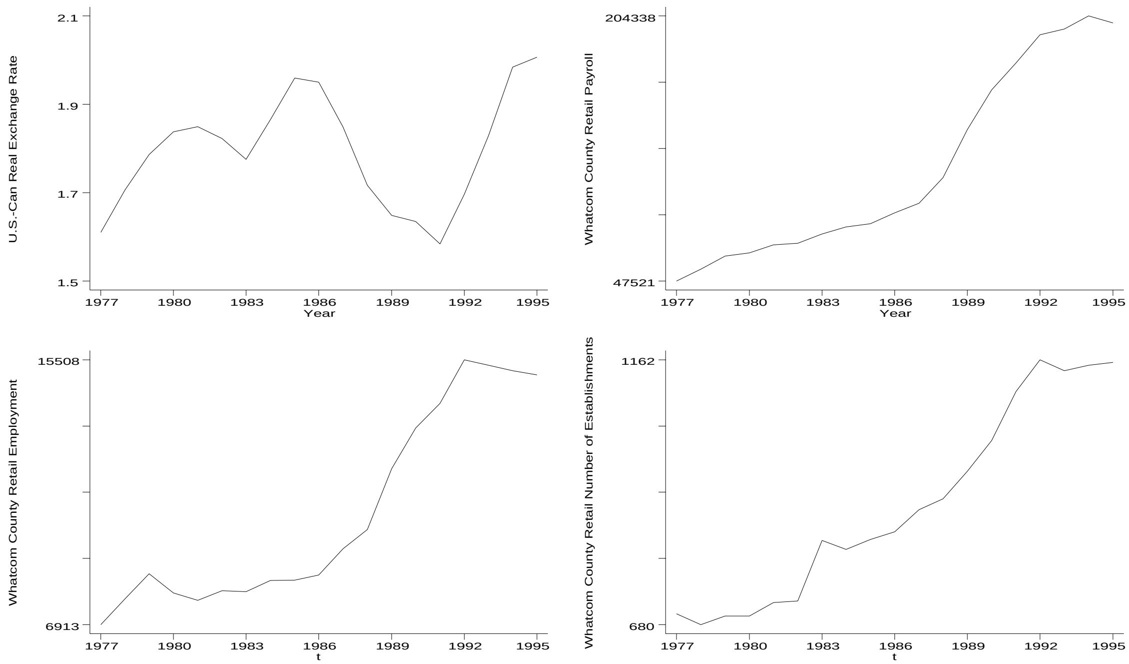

Figure 2: Whatcom County Variables

Figure 3
Free Entry Reaction Curves